

IN THE DRAWINGS:

Applicant herewith submits substitute formal drawings for Figures 7 and 8, each marked
Substitute Sheet.

REMARKS

In the office action mailed December 15, 2004, claims 1 - 2, 6, 14 and 24 were rejected under 35 U.S.C. §102(b) over U.S. Patent No. 5,003,572 (to Meccariello et al.); claims 32 and 34 were rejected under §102(b) over U.S. Patent No. 4,639,943 (to Heinze et al.); claims 1 - 7, 11, 13, 15 - 18 and 22 - 23 were rejected under 35 U.S. C. §103(a) over Heinze et al. in view of Meccariello et al.; and claims 8 - 10, 12, 19 - 21, 24 - 25 and 27 - 31 were rejected under §103(a) over Heinze et al. in view of Meccariello et al. and U.S. Patent No. 6,661,876 (to Turner et al.). Claim 26 was indicated as being allowable if re-written in independent form.

Claims 1 - 34 are canceled herein and new claims 35 - 70 are added.

The present invention is directed to an X-ray detector feedback system in which the *output X-ray signals* are monitored and controlled. This is very different than monitoring *exposure* or *quality* of X-ray imaging through a subject such as a patient. When the exposure or quality of images of a subject is employed to provide feedback to an X-ray source, the X-ray output may be varied to achieve a desired image quality. Such systems may assume, therefore, that the X-ray output signal remains constant when the control signal that drives the X-ray tube remains constant. In particular, relatively high power X-ray systems (such as for use in medical imaging) typically ignore very small changes or fluctuations in the X-ray output signal that occur due to a variety of factors such as changes within the X-ray tube.

With low power X-ray tubes, however, variations within the X-ray tube such as changes in leakage current and/or changes in the focal spot of electrons on an anode during use, may result in changes in the X-ray output even while the control signal remains constant. Because applicants are interested in providing a relatively low power X-ray source, these fluctuations become more significant, and may compromise the stable operation of the X-ray source at low

power levels.

In order to control the X-ray output itself, the system must detect a signal that is truly representative of the output X-ray signal, without negatively affecting (e.g., significantly blocking) the output X-ray signal. Systems that simply place a detector near the path of the X-ray output do not achieve this because the detected signal may be affected by environmental changes such as the presence of an X-ray reflecting object that appears near the X-ray output path. Moreover, the subject itself (that is in the X-ray output path), may reflect X-rays and thereby detract from the reliability of the detector signal as being representative of the X-ray output.

The Meccariello et al. reference discloses an X-ray video imaging system in which X-rays are directed toward (and through) a subject, and are later received by a camera and a gain amplifier. The output of the camera is coupled to an exposure control system that involves controlling the gain of the gain amplifier, the filament power supply, the pulse width, and the high voltage power supply. The Meccariello et al. reference, however, does not disclose a system in which the *X-ray output* is controlled responsive to changes in conditions within the X-ray tube. In fact, the control disclosed in the Meccariello et al. reference is achieved responsive to exposure through a subject.

The Heinze et al. reference discloses an X-ray diagnostic system that includes a control loop for regulating the quality of an X-ray image through a subject. The system includes a first radiation detector (8) that detects the mean image brightness in a predetermined region of the image (Heinze et al., col.2, lines 39 - 41). The system also includes a second radiation detector (16) that provides an output signal to a transformer 17 in a second regulating stage (Heinze et al., col.2, lines 61 - 63). Although the second regulating stage employs a memory storage to regulate

the dose of X-rays being supplied to the subject (Heinze et al., col.2, line 61 - col. 3, line 2), this is not achieved responsive to changes in conditions within the X-ray tube. Rather this control is achieved instead to maintain the mean image brightness that was recorded during the first regulating stage. The Heinze et al. reference does not disclose a system in which the X-ray output is controlled responsive to changes in conditions within the X-ray tube.

The Turner et al. reference discloses a mobile miniature X-ray source, but does not appear to disclose a system that includes a detector that provides any type of *feedback* to the X-ray source. The Turner et al. reference, therefore, also does not disclose a system in which the X-ray output is controlled responsive to changes in conditions within the X-ray tube.

Independent claim 35 is directed to a system for controlling the X-ray output of an X-ray tube. The system includes an X-ray tube, an X-ray *transmissive* detector, and a control system. The X-ray tube emits an X-ray output in response to a control signal. The X-ray transmissive X-ray detector (*through which* at least a portion of the X-ray output passes) detects X-rays emitted from the X-ray tube, and provides a detected X-ray signal indicative of a property of the X-rays that are emitted by the X-ray tube. The control system receives the detected X-ray signal and adjusts the control signal *responsive to changes in conditions within the X-ray tube* to ensure that the X-ray output signal is substantially maintained at a predetermined value.

None of the Meccariello et al., Heinze et al or Turner et al. references, in any combination, teaches, discloses or suggests an X-ray system in which a control signal for the X-ray tube is adjusted responsive to changes in conditions within the X-ray tube. The additional prior art of record and cited in the accompanying Information Disclosure Statement, also each do not disclose a system in which the X-ray output is monitored using an X-ray transmissive detector and in which the X-ray output is controlled responsive to changes in conditions within

the X-ray tube.

Claim 35, therefore, is submitted to be in condition for allowance. Each of claims 36 - 57 depends directly or indirectly from claim 35, and is also submitted to be in condition for allowance.

Independent claim 58 is directed to a system for controlling the X-ray output of an X-ray tube. The system includes an X-ray tube, an X-ray detector and a control system. The X-ray tube emits an X-ray output through a window in response to a control signal. The X-ray detector (on which substantially all of the X-ray output impinges), provides a detected X-ray signal indicative of a property of the X-rays that are emitted by the X-ray tube through the window. The control system receives the detected X-ray signal and adjusts the control signal responsive to changes in conditions within the X-ray tube to ensure that the X-ray output signal is substantially maintained at a predetermined value.

Again, none of the Meccariello et al., Heinze et al or Turner et al. references, in any combination, teaches, discloses or suggests an X-ray system in which a control signal for the X-ray tube is adjusted responsive to changes in conditions within the X-ray tube. The additional prior art of record and cited in the accompanying Information Disclosure Statement, also each do not disclose a system in which the X-ray output is monitored using an X-ray detector on which substantially all of the X-ray output impinges, and in which the X-ray output is controlled responsive to changes in conditions within the X-ray tube.

Claim 58, therefore, is submitted to be in condition for allowance. Each of claims 59 and 60 depends directly from claim 58, and is also submitted to be in condition for allowance.

Independent claim 61 is directed to a system for controlling the X-ray output of an X-ray tube. The system includes an X-ray tube, an X-ray detector, and a control system. The X-ray

tube emits an X-ray output through a window in response to a control signal. The X-ray detector is at least adjacent the window and at least some of the X-ray output impinges on the X-ray detector. The X-ray detector provides a detected X-ray signal indicative of a property of the X-rays that are emitted by the X-ray tube through the window. The control system receives the detected X-ray signal and adjusts the control signal responsive to changes in conditions within the X-ray tube to ensure that said X-ray output signal is substantially maintained at a predetermined value.

Again, none of the Meccariello et al., Heinze et al or Turner et al. references, in any combination, teaches, discloses or suggests an X-ray system in which a control signal for the X-ray tube is adjusted responsive to changes in conditions within the X-ray tube. The additional prior art of record and cited in the accompanying Information Disclosure Statement, also each do not disclose a system in which the X-ray output is monitored using an X-ray detector that is at least substantially adjacent the window, and in which the X-ray output is controlled responsive to changes in conditions within the X-ray tube.

Claim 61, therefore, is submitted to be in condition for allowance. Each of claims 62 and 63 depends directly from claim 61, and is also submitted to be in condition for allowance.

Independent claim 64 is directed to a method of controlling the X-ray output of an X-ray tube. The method includes the steps of providing an X-ray tube that emits an X-ray output in response to a control signal, providing an X-ray transmissive X-ray detector through which at least a portion of said X-ray output passes that detects X-rays emitted from said X-ray tube, providing a detected X-ray signal indicative of a property of the X-rays that are emitted by the X-ray tube, and adjusting the control signal responsive to changes in conditions within the X-ray tube to ensure that the detected X-ray signal is maintained at a substantially predetermined value.

As discussed above, none of the Meccariello et al., Heinze et al or Turner et al. references, in any combination, teaches, discloses or suggests a method for controlling the X-ray output of an X-ray tube in which a control signal for the X-ray tube is adjusted responsive to changes in conditions within the X-ray tube. The additional prior art of record and cited in the accompanying Information Disclosure Statement, also each do not disclose a method for controlling the output of an X-ray tube in which the X-ray output is monitored using an X-ray transmissive detector, and in which the X-ray output is controlled responsive to changes in conditions within the X-ray tube.

Claim 64, therefore, is submitted to be in condition for allowance. Each of claims 65 - 67 depends directly or indirectly from claim 64, and is also submitted to be in condition for allowance.

Independent claim 68 is directed to a method of controlling the X-ray output of an X-ray tube. The method includes the steps of providing an X-ray tube that emits an X-ray output through a window in response to a control signal, providing an X-ray detector that is at least adjacent the window and on which at least a portion of the X-ray output impinges, providing a detected X-ray signal indicative of a property of the X-rays that are emitted by the X-ray tube, and adjusting the control signal responsive to changes in conditions within the X-ray tube to ensure that the detected X-ray signal is maintained at a substantially predetermined value.

Again, none of the Meccariello et al., Heinze et al or Turner et al. references, in any combination, teaches, discloses or suggests method for controlling the X-ray output of an X-ray tube in which a control signal for the X-ray tube is adjusted responsive to changes in conditions within the X-ray tube. The additional prior art of record and cited in the accompanying Information Disclosure Statement, also each do not disclose a method for controlling the output

of an X-ray tube in which the X-ray output is monitored using an X-ray detector that is at least substantially adjacent the window, and in which the X-ray output is controlled responsive to changes in conditions within the X-ray tube.

Claim 68, therefore, is submitted to be in condition for allowance. Each of claims 69 - 70 depends directly from claim 68, and is also submitted to be in condition for allowance.

Each of claims 35 - 70, therefore, is submitted to be in condition for allowance. Favorable action consistent with the above is respectfully requested.

Respectfully submitted,



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